



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

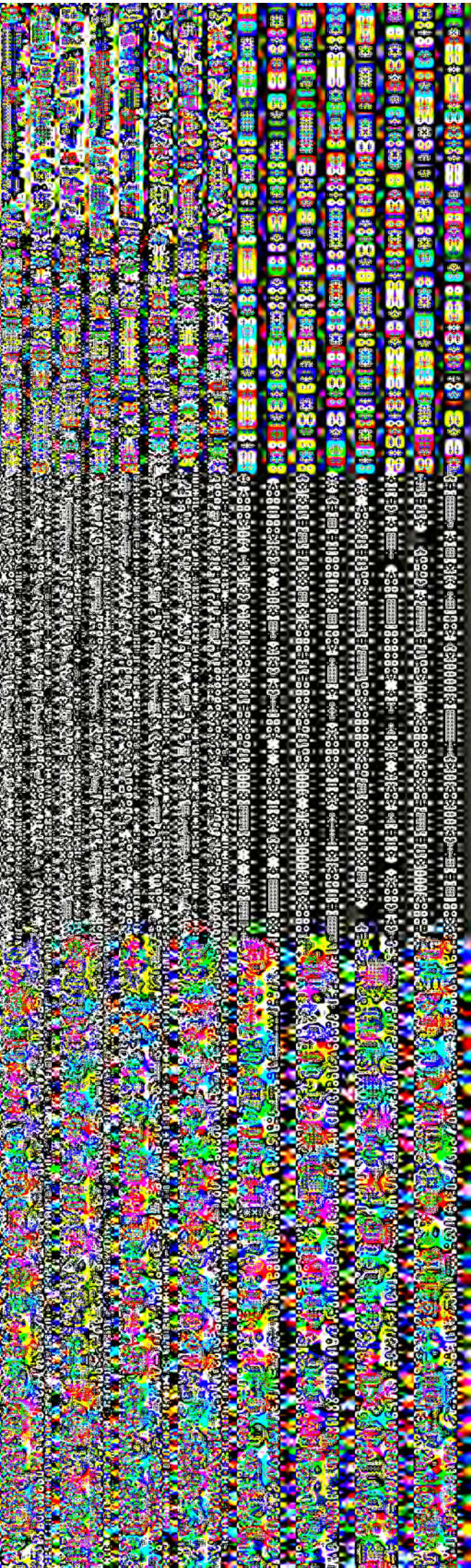
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

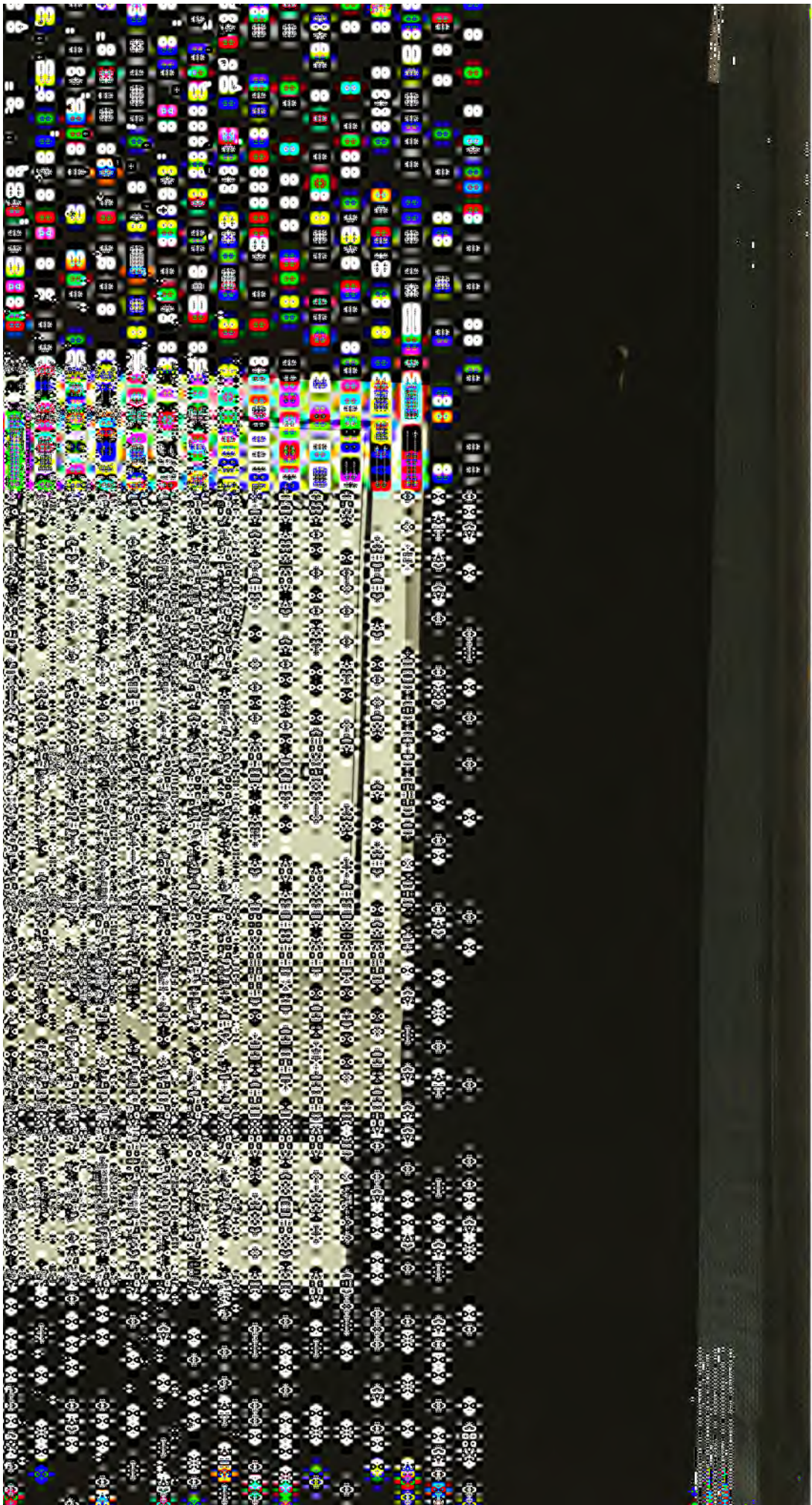
We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>





g-2

GEOLOGICAL SURVEY

Geologist

OBJECT, SCOPE, AND

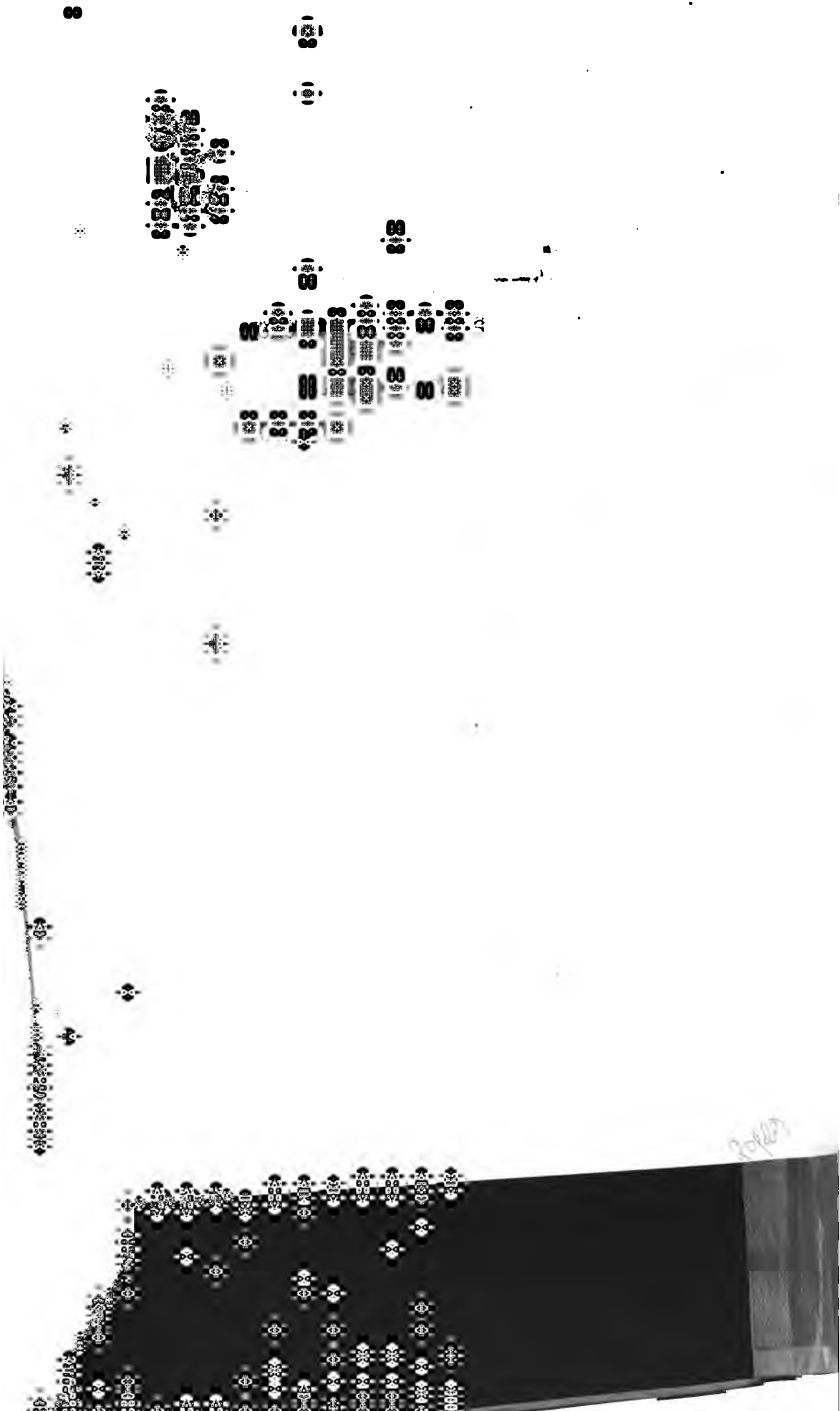
GEOLOGICAL SURVEY

WILEY

GEOLOGICAL WORK

WILEY
COMPANY





CONTENTS.

	PAGE.
The Establishment of the Survey.....	5
The Bill	7
Organization of the Survey.....	9
Purpose of the Survey.....	10
Scope of Work	11
General Geology	12
Geography	13
Metals and Their Ores.....	15
Fuels and Fertilizers.....	16
Structural Materials and Materials Used in the Arts.....	17
Water and Water Power.....	18
Soils	18
Conservation and Reclamation of Land.....	19
Forests, Roads, etc.	20
Work of the Survey.....	22
Field Work	22
Office Work	24
Laboratory Work	26
Exhibit and Educational Work.....	27
Publication	28
Coöperation	30
Relations to Public.....	32



THE ESTABLISHMENT, PURPOSE, SCOPE, AND METHODS OF THE STATE GEOLOGICAL SURVEY.

By GEO. H. ASHLEY.

THE ESTABLISHMENT OF THE SURVEY.

The natural resources of any State or nation form the basis of its material advancement, and their development and use measure its wealth and progress. Tennessee is rich in mineral and other resources. Extending from the oldest rocks in the crest of the Appalachians to the newest rocks forming the bottoms of the Mississippi River, there is embraced within its borders a variety and richness of soils, of climate, of rock strata, of zones of ores and other minerals, hardly excelled by any other State in the Union. This is reflected in the fact that to-day she leads every other Southern State, except Alabama, in mineral production; that her mineral production in 1908 was larger than that of North Carolina, South Carolina, Georgia, Mississippi, and Arkansas, all put together; more than twice as large as that of Florida, and nearly twice as large as that of Louisiana, but, on the other hand, only a little more than half as large as that of Alabama.

And yet, with a few exceptions, she is making relatively little use of many of her resources, as compared with some other States no more favored, except by markets, and to a large degree Tennessee is one of the markets of those other States, rather than supplying her own needs. Thus, with probably as large deposits of clay as Ohio, she produces to-day only about one-twentieth as much value in clay products, and goes to Ohio and other States to supply more or less of her own needs. With probably as large deposits of suitable material for the manufacture of cement as Indiana, she produces only one-eighteenth as much, and makes a market for



OSE, SCOPE, AND

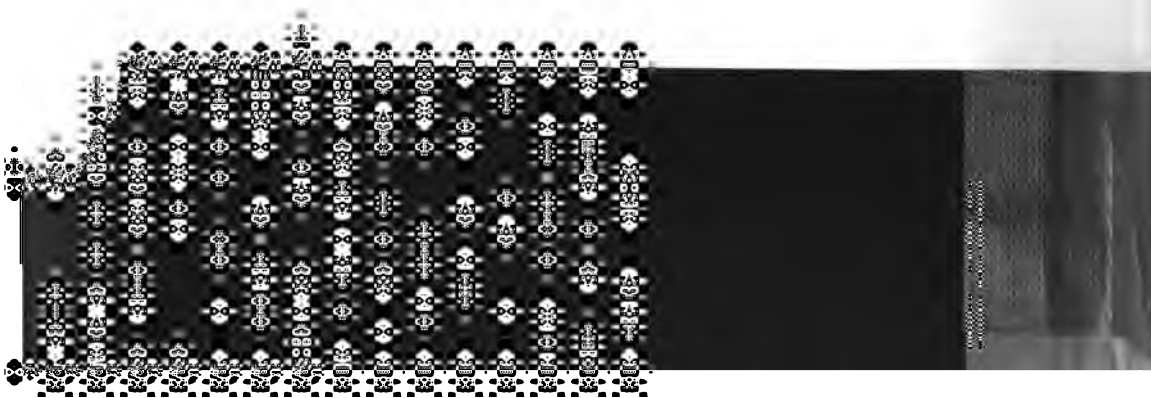
many times as much iron
one-twenty-eighth as much
be multiplied. But it is not
ls that an advance is possi-

Every pound of raw mate-
supplying some other State
Michigan supplies raw iron
Pennsylvania works it up into
to steel rails or other mate-
an extent is Pennsylvania's
of other States? To how
supplying other States with

for the last ten years has
has been a leading figure.
ization that to-day the South
the far West thirty to sixty
in the increase of population
ation of industrial plants of
lands and abandoned farms;
and literature; and in a thou-
looking for investments and
to worthily win their way
the South, and the young men of
necessary to go North or West to

a growing demand for in-
know the things they desire
estments will hardly come to
Clays—Occurrences, Properties,
regarding the clays of Ten-
ate." (Page 420.) He will
authoritatively that the clays
tions of transportation, etc.,
to maintain the preëminence
alone that she realize more
and the possibilities of their
to the world. Who can tell
mineral production Alabama
State Geological Survey she has

that led the State Legislature



the establishment of a State

as follows:

300.

er, and Neal.)

and create the bureau to be known
objects, powers, and duties; pro-
gist, and defining his powers and
and State bureaus in furthering
publication of the results of the
of the natural resources of the
equipment and property of the sur-
in the prosecution of the work
for the enforcement of this Act.

Assembly of the State of Tennessee,
established a bureau to be known as
under the direction of a Commis-
"Commission," composed of the Gov-
and Commission), the State Commis-
the President of the University
University, and the Vice Chancellor

id Commission shall have general
all appoint as Director a Geologist
as the "State Geologist," and upon
assistants, and employees as may
edly the work of the survey.
Employees appointed under the pro-
sation as shall be determined by
shall serve without compensation,
incurred in the performance of their

aid Commissioners shall meet for
the passage of this Act, and shall appoint
regular meetings of the Commis-
May and the first Wednesday in
Commission shall determine.

be the duty of the State Geologist,
to organize and direct the work of
to determine the character, order,
survey, and to direct the prepara-

POSE, SCOPE, AND

to arrange for coöperative work
bureaus where such work shall
State; to appoint such associates,
try to carry out successfully and
and have charge of the necessary
and supervise the acquisition, care,
the Geological Survey; and to per-
the successful conduct of the sur-
Assembly before each meeting of
tion of the survey, together with
deem necessary and useful.

State Geological Survey shall have

the State, with especial reference
oil, gas, ores, fertilizers, building
materials, sands, soils, forests, min-
streams, and water powers, and

relations of the soils of the State,
to particular crops, the maintenance
utilization of supplies of natural fer-

the State, with reference to their
of utilizing the same.

of underground water supplies.
and water powers of the State,
and development for industrial en-

able lands of the State, with refer-
poses.

State, with reference to their bear-
intellectual pursuits of the people.
necessary illustrations and maps,
descriptions of the geology, topog-

ographic, and economic maps to
sources of the State.

ific and economic questions as in
emed of value to the people of the

lar and special reports of the State
and maps, shall be printed and dis-
sem best for the interest of the peo-
direct, and all moneys obtained by
State treasury. The said Commis-
the General Assembly before each
d condition of the survey, together
them necessary and useful, or as the
however, that the Commission shall
reports.

SEC. 7. *Be it further enacted*, That after having served the purposes of the Survey, all materials collected shall be distributed by the Director to the educational institutions of the State in such manner as the Commission may determine to be of advantage to the educational interests of the State; *provided, however*, that if deemed advisable, the Commission may first use such portion as may be necessary to establish a permanent exhibit of the natural resources of the State. On the completion or discontinuance of the State Geological Survey, the Commission shall cause all records, notes, books, reports, charts, maps, manuscripts, instruments, and other equipment and property of the survey to be placed in charge of a suitable custodian to be held subject to final disposition by the General Assembly; *provided, however*, that any field or other equipment which the Commission shall deem it undesirable to preserve may be sold as the Commission may direct and the money turned into the State treasury; and, *provided, further*, that the copies of the reports of the survey left on hand for distribution shall be distributed by the custodian in such manner as shall be for the best interest of the people of the State.

SEC. 8. *Be it further enacted*, That the said Commission is hereby authorized to enter into coöperation with the United States Geological Survey and other scientific bureaus of the Federal and State governments for the prosecution at joint expense of such work in the State as shall be deemed of mutual interest and advantage, and under such conditions as said Commission may deem to be for the best interest of the people of the State.

SEC. 9. *Be it further enacted*, That in order to carry out the provisions of this Act, it shall be lawful for any person employed hereunder to enter and cross all lands within the State; *provided*, that in so doing no damage is done to private property.

SEC. 10. *Be it further enacted*, That for the purpose of carrying out the provisions of this Act, fifteen thousand dollars (\$15,000) annually for the years 1910 and 1911, or so much thereof as may be necessary, is hereby appropriated out of any money in the State treasury not otherwise appropriated, and the State Treasurer is hereby authorized to pay out the same on the warrants of the Comptroller upon the presentation of the proper vouchers by the Chairman of said State Geological Commission; *provided*, that the appropriation made herein shall not be available until May 1, 1910.

SEC. 11. *Be it further enacted*, That this Act take effect from and after its passage, the public welfare requiring it.

Passed April 30, 1909.

WM. KINNEY,
Speaker of the Senate.

M. HILLSMAN TAYLOR,
Speaker of the House of Representatives.

Approved May 1, 1909.

MALCOLM R. PATTERSON,
Governor.

ORGANIZATION OF THE SURVEY.

Under the terms of the bill, the Geological Commission consists of Malcolm R. Patterson, Governor of Tennessee, ex-officio Chairman; John Thompson, State Commissioner of Agriculture; R. A.

Shiflett, Chief Mine Inspector; Brown Ayres, President of the University of Tennessee; J. H. Kirkland, Chancellor of Vanderbilt University; and William B. Hall, Vice Chancellor of the University of the South. The commission held its first meeting on February 7, at which time an organization was perfected and a committee appointed, consisting of President Ayres and Chancellor Kirkland, to canvass the field and recommend a suitable man for the position of State Geologist. As a result of their recommendation, at a meeting held on March 16, the commission elected, as State Geologist, George H. Ashley, of the United States Geological Survey, at the time in charge of work in the eastern coal fields; and as Associate Geologists, Mr. Charles H. Gordon, Professor of Geology at the University of Tennessee, and Mr. L. C. Glenn, Professor of Geology at Vanderbilt University.

On May 1 the Survey began active operations. An office in the Capitol Annex, at Nashville, was made ready and properly equipped with the apparatus necessary for conducting the operations of the Survey. Plans for the first season's work were made, including many for coöperative work with the bureaus of the United States Government at Washington; assistants were selected and work begun.

PURPOSE OF THE SURVEY.

The purpose of the Survey may be briefly stated: The Geological Survey of Tennessee exists to obtain and publish accurate, definite, and unbiased information on the State's natural resources for the purpose of increasing the wealth and well-being of the State and its citizens through a larger and better use of those resources.

The Survey will be of direct value to the State in several ways: (1) By serving as the State's expert in determining the value, etc., of the State's present large holdings of mineral lands, or of any proposed additional purchases or sales; (2) by supplying the facts and information necessary to intelligent legislation concerning the State's resources; (3) by conserving the State's resources through leading to better methods of obtaining and using them; (4) by helping to bring into the State new capital for investment and the immigration of new citizens; (5) by keeping money in the State through aiding in the establishment of local industries to supply local needs, and by bringing additional money in by enlarging the output of farms, mines, and factories; (6) by leading to added sources of income for the State.

The Survey will be of indirect value to the State through its value to the individual citizens for whose welfare the State exists.

showing what ores, minerals, and land; their depth, volume, and it affects the possible sale of such use of his land and the return. It is of value to giving unbiased information of industries established. It is by increasing the volume of things to be moved, through an demand. It is of value to most of us, by reducing costs of things that must otherwise be increased by increasing the supply of things without work by increasing the starting of new or enlarging

the abating of the smoke nuisance for light and power through a saving and making effective lands, in converting poor farm lands, and in other ways, it may give more of the comforts and

WORK.

information on certain subjects of the information; second, the preparation of that information; and third, the dissemination of that information. It is to serve as a bureau of information under Section 5 of the Act under which it may be grouped as follows: physics, and chemistry, so far as they affect the interests of this State.

used in the arts.

acts.

PURPOSE, SCOPE, AND

suggested by running over briefly a few of the lines of information questions are asked.

tells what the rocks are composed of, where they came to be found in their present position, how they have changed from their first condition at the time they were deposited, the influence of earthquakes, mountain building, and the history of the earth's surface, and answers many other questions. Sometimes questions are asked of themselves by those desiring to know more of the world about these things is desired because of its importance to any scientific study of the earth.

It is a matter of common knowledge that minerals, rocks, fuels, etc., are distributed in the world, nor, on the other hand, do they occur as though by mere chance. The world, when brought together, the occurrences of these materials, or of other conditions brought together, make up the

geologist draws a line around a certain area and says, "Within this line there is a certain amount of coal, outside of it there is none," he is giving you the name of "theoretical" information. He tells you the age of the rocks within the line, and the fact that of that line, involving in turn the fact that there is a line in these rocks through which the general meaning and relations of the world, and the fact that he knows the approximate age of the world, and the fact that the whole coal ever has been found in the rocks outside of the line. He draws certain belts across the world. If you are interested in zinc, look outside," he is again basing his information on mining zinc everywhere and the fact that there is a line in the world. To-day there are several different kinds of miners, and others who are concerned with the character of the deposits of

books and describing them in
are printed each year. But
ste much of their time to
ing to any one subject and
based on experience from
usions form the *science* of
ained geologist must know
any value to the State em-

and mining men, not only in
ct that, with the establish-
ee, they in turn will receive
conditions surrounding the
osits of this State, forming
l science of geology. It is,
the so-called "theoretical"
ailed description of ores or
from time to time general
or a large part of the facts
description of fossils, the
origin of various deposits, of
rocks, or of any part of the
many other similar subjects.

tion of the present work, a
the State had already been
Safford, Killebrew, Hayes,
Ulrich, and others; but in
survey many other problems
to be worked out and pub-
s.

Geological Surveys have al-
of maps showing the geog-
well as the geology of its
ke on several forms.

of meridian lines. Just as
he mountains, is constantly
the woodman's porch a north
ck in lieu of a clock, so the
surveyors to establish at the


It is well known that the
t to the magnetic north pole,
nstantly shifting from year

to year, so that the land line described by the points of the compass in 1850 will not agree with the same points of the compass in 1910. In securing these meridian lines, the State Survey will coöperate with the Coast and Geodetic Survey.

The making of maps will form no small part of the work of the Survey. These will range from small scale maps of the State, showing only the county seats, to large scale detailed maps of small areas, showing all of the roads, trails, houses, streams, the exact shape of the hills and valleys, the location of the mines, quarries, springs, etc. Some of the more detailed maps will show every five-foot change of level in the ground. These maps may be published simply as geographical maps for the use of engineers, surveyors, travelers, landowners, prospectors, or other people; or they may form a basis on which are placed facts about the geology or soils or timber, the roads, water supply, markets, or any one of those things with which the Survey is to deal.

High-grade, plain, geographic maps, showing the topography, are much studied and used, where they exist, for the location of steam and electric railways, of State and county highways, of schools, telegraph and telephone lines, for the laying of water pipes, aqueducts and sewerage systems, for the drainage or irrigation of land, for the position of county and township lines, for selecting the best routes for automobile tours or tramps, in planning maneuvers of the National Guard, in connection with the purchase or sale of land, in gaining exact knowledge of the country, elevation of places, distances and directions between places, and for a multitude of other uses.

In the early days the geologists made their own maps as they went, and in reconnoissance work that is often still necessary; but where detailed work is to be done, requiring detailed topographic maps on which to publish the geologic results, it has been found much more economical to train men for the specific purpose of map making. To obtain such maps, there is required accurate primary and secondary triangulation, traverses, and leveling work. The preparation of such maps is expensive, costing from \$4 to \$50 per square mile, according to the scale of the map and the character of the country. It has been the practice of most of the States needing such maps to ask the coöperation of the Topographic Branch of the United States Geological Survey, which stands ready within the limits of its funds to make such maps where requested, the State and national governments sharing alike in the cost of the field and office work, but the national government assuming the entire cost



of engraving and printing the maps. At present forty-eight per cent of Tennessee, mostly in the eastern and central parts of the State, has been covered by such mapping, which, in most cases, has been followed by geologic mapping. The early maps, both topographic and geologic, were done rapidly and at small cost. Gradually the grade of such work has been improving, until to-day the United States Government frankly labels later editions of the early maps as "reconnaissance" maps. As the grade of geologic work has risen, it has been found necessary to have better and better topographic maps in order to adequately represent the geologic facts obtained. This has continued until to-day the older topographic maps are entirely inadequate for the representation of geologic facts as obtained by modern methods. The first step in geologic work has, therefore, been the securing of adequate topographic maps.

Fortunately, for the beginning of the new work in Tennessee, a few of such up-to-date topographic maps have been made in this State within the last few years. The recent topographic maps on hand will suffice for the geologic work for the first season or two, but soon active steps must be taken to secure similar good maps of other areas on which the Survey desires to do work. Efforts to secure additional modern topographic maps in Tennessee by the United States Geological Survey will be made.

The present funds of the Geological Survey of Tennessee do not warrant seeking such coöperation, except to a very limited extent. It is hoped in the future that more funds will be available for that specific object.

Metals and Their Ores.—In their occurrences the ores of the metals may be divided into two classes: those which occur as original bedded deposits, as the Clinton iron ore of Tennessee, and those which, in a sense, are secondary in their occurrence—that is, have been brought together after the deposition of the containing rocks by segregation, replacement, or otherwise, and occur in veins or other irregularly shaped deposits. Deposits of the first class would be studied very much as are the beds of coal, as described in the following section. In the study of ores of the second class, the Survey will attempt to find out for each of the metals just what formations may contain its ores, to delimit these formations on the map so as to show in just what parts of the State the ores of that metal may or do occur. Then it will try to determine under just what conditions or combinations of conditions the ores do or may occur, and to point out where these conditions exist, using large-scale detailed maps for the purpose. This will involve a study of

the occurrence and origin of all of the known deposits in the State, combined with a knowledge of similar deposits elsewhere. In brief, the aim will be to study the occurrence and origin, the character, extent, and value of all of the known deposits in the State of the metallic ores, first, in order to secure or extend their development; second, to point out just where else they may occur and how they may be recognized; and, third, to tell how they are mined and marketed and to what uses they are or may be put.

Fuels and Fertilizers.—Most fuels and fertilizers have, in common, an origin from living forms, either plants or animals, and are deposited in beds often of considerable lateral extent, but of small vertical extent. In many ways the same methods will be followed in tracing phosphates as in tracing coal beds.

Thus, in studying the coal of the State, the Survey will seek to determine the exact limits of the coal field, the series of rocks in that field, the number of coal beds and their position in that series of rocks. Of each bed it will try to determine the average thickness and the variations of thickness from place to place; its analysis, quality, purity, freedom from shale partings, binders, etc.; the character of its roof, floor, etc., as affecting its workability; its distance above or below some conspicuously outcropping rock, so that, by reference to it, the coal bed may be found; the position of the bed in the hill; its probable extent and character in any direction or under any given area; its dip or lay, giving very closely its exact depth at any point; the total tonnage that should be recovered from it; the methods of working, preparing, and marketing the coal; and, finally, the various uses to which it can be put, and especially the more recent advances that have been made in the use of coal. In this work, again, it will be attempted to show on the map accurately the position of each principal coal bed, so that any one with the map in hand could go at once to the position of its outcropping and, by prospecting, determine its presence and local character.

The occurrence of oil does not lend itself so readily to accurate description and forecast. It is a common idea outside of the oil fields that the discovery of oil is the result of hunting over the surface for oil seepage or other visible evidence of oil. It is true that in a few cases the discovery of an oil seepage has been followed by striking oil in a well bored on that evidence; but it is probably also true that not one successful oil well in a thousand has been located on such evidence; while, on the other hand, of all the oil wells drilled on such evidence, probably four-fifths have never paid back the cost of drilling. The successful oil men have always followed

"leads" consisting of lines of structure, water conditions, etc. Oil, like water, runs down hill, and, if it is not associated with water, will accumulate in the lowest part of a fold in the rocks containing it. If it is associated with water, it will, on account of its lightness, tend to rise to the top of the water, which may be along the top of the fold if the rock is full of water, or along the flank of the fold if the rock is only partially saturated. These are a few of the most simple elements of the many that control the occurrence of oil. Within certain broad limits it is possible that oil may be found anywhere in the rocks. Actual experience in any given territory shows that certain beds are more likely to contain oil than others, and under certain conditions of structure, water content, and other factors.

It is the office of the Geological Survey to seek to determine what beds of rock have been shown, by experience, are most likely to contain oil and gas, and under what conditions, and to determine where else those beds occur under those conditions in this State. In this work coöperation with the experts of the Federal Survey will be sought, in order to gain the advantage of their intimate knowledge of the conditions holding in the large developed oil fields of the country.

Phosphate rocks form one of the most valuable assets of this State. Work already done on them has shown that they occur at a few very definite horizons or as secondary deposits made by the weathering of the original deposits and the redeposition of the phosphates. It will be the aim of the Survey to determine accurately just what the limiting conditions are under which the phosphates of this State occur, and then to trace, in detail, the occurrence of these conditions, testing the rocks chemically in the field as the work progresses, and showing the position of the rocks that are found to be phosphatic on detailed maps.

Structural Materials and Materials Used in the Arts.—Under this heading will come a large variety of substances, some of them of the first rank in importance, others of only minor importance. Thus it will include marble, limestone, cement rocks, lithographic stone, sandstone, clays, shales, slates, barytes, pyrites, fluor spar, whetstone, glass sand, salt, nitre, silica rock, and many other rocks and minerals of greater or less value. For the present purpose it will suffice to point out some of the lines of study connected with one or two of the substances listed, as, for example, marble and clay rocks.

Marble is a crystallized limestone suitable for fine structural work. The limestones are among the regularly bedded rocks, and their general outcrop has already been mapped. It is probably true that

only a few of the many beds of limestone in this State are ever found in the condition of marble. It will be the purpose of the Survey to determine which of these beds contain marble and to follow their outcrops wherever they occur in the State, examining the rock at every exposure, and showing by detailed maps just where they appear to be of sufficiently high grade to serve as commercial marble. This will include a detailed study of the stratigraphy or position among the rock strata, of all of the known marble deposits, of the fossils by which these particular beds may be recognized, and, afterwards, the detailed tracing and mapping of these beds with close scrutiny for marble.

The clay rocks, from which bricks, tile, terra-cotta, China ware, etc., are made, occur in the earth as regularly deposited beds of clay or shale, or they occur as surface deposits, having been derived from older rocks by decomposition and water transportation. Where they are regularly bedded, it is possible to determine just their stratigraphic position in the rocks. The preliminary work will consist of a study of the developed deposits and the determination of their position, character, etc., and that will then be followed by the detailed tracing, testing, and mapping over the State of the beds that experience or examination shows to contain deposits of commercial character.

The surface deposits are more irregular in their character and disposition, but, aside from those found in the bottoms along streams and rivers, will usually be found associated with certain rocks under certain conditions. The Survey will seek to discover what these associations and conditions are, and then to trace and map wherever these associations and conditions exist.

Water and Water Power.—The lines of inquiry in regard to water (aside from rainfall, which is looked after by the National Weather Bureau) deal with run-off of the surface streams, conditions affecting it, and the results under different conditions, as well as possible modifications of the present conditions so as to give better control of the run-off; surface springs, both clear and mineral; underground water supplies, artesian well areas, water-bearing levels or strata; possible sources of water power, with minimum and maximum derivable power, and the problem of its use and transportation; navigation of rivers, water for irrigation, etc.

Soils.—After all is said and done, the soil is the earth's great storehouse, furnishing man with his most fundamental necessities—food, clothing, and shelter—and, when properly cared for, continuing to do this from century to century with undiminished gen-

ms: First, the maintenance of chemical substances; second, the possible point. In a large in which raw materials are essentially it is composed of do not enter at all into the time the raw materials—some the water, to come and go, tion of the soil is mainly an under the next head. The subject of almost unlimited the State Survey, working in already in the field, to make the State; to learn its origin, contents; to determine to what present condition; to see if its by some different handling, to see if it is not lacking in the best farmers now living sometimes noting the experi- similar soils, or the result of the studies having been made ready in the field, it will be survey to trace, in detail, the are maps of the same. Here is opportunity for detailed topographic detail to be worth while. lands.—While it must needs and carried away to the sea, this movement should be as is washed from the hills no weathering can break up the will be no permanent harm the erosion does damage that land that should have been all time. Again, if this ma- is away than it can be carried off, it from lands and to hinder navi- tion of soils and the preven- form one subject of study by the reclamation of the bottom

lands of parts of West Tennessee. This is being done by districts organized under the drainage law of 1909. (See Bulletin No. 3, Part C.) These drainage districts are usually organized to cover the portion of any valley lying in one county. This may include the whole valley. Usually it will not. Experience, too often disastrous, has shown the necessity that all drainage work be planned with a knowledge of all of the factors and conditions in the case if the work, when completed, is to be efficient and economical. That it may be both, requires a knowledge of many factors that it may be difficult to get in any one district, or which have already been obtained in some other district. It is, therefore, felt to be the special province of the Geological Survey in aiding in this work to first take such parts of the work as are general in their nature, bringing to the districts such necessary data as that on rainfall, run-off, etc., carrying on observations and experiments where necessary and drawing on the experience of other districts in this and other States where possible.

Again, where there are several drainage districts on the same stream in different counties, it is most desirable that there be some way of coördinating the plan of construction in one district with that in the districts above and below. Otherwise, as has sometimes happened, the construction in one district may follow a different plan from that in the other districts, resulting locally in a worse condition than at first—endless lawsuits, injunctions, etc. It is, therefore, the hope of the Survey to lend its friendly aid, as far as possible, in securing coördination of plans along any one stream.

The work will include not only reclamation of land rendered nontillable because of flooding, but the reclamation of lands from which the soil has been allowed to wash away, or which, for any other reason, has been allowed to become barren and nontillable.

Forests, Roads, Etc.—The forest, like the soil, is one of those things that, if properly cared for, will continue itself indefinitely. It is, however, usually treated as one of the things to be exterminated. Over large areas the forest has had to give way to fields and pastures, but there still remain large areas not suited to the cultivation of crops or the raising of cattle. Too often from these areas the native growth of timber has been removed and no effort made to grow a new crop of timber. In the past it has been the general tendency to look upon timber as one might upon rabbits, or bears, or buffaloes—as a part of nature's "wild stuff," to be gotten while it lasts; for when it is gone, it is gone. Of late years there has been a growing appreciation that just as we no longer

think of depending on wild strawberries or wild rice for our supply, so will we not much longer depend on wild timber for our supply. With that appreciation is a growing demand for information about the proper way to cultivate timber; the general conditions of soil, topography, and climate best adapted to timber raising; the kinds of trees best adapted to any given soil, or other factors, etc. As it is at once recognized that the raising of timber will be vastly easier where there is already some of the desired timber on the land, there will be three lines along which inquiry will be made: First, the facts concerning the present supply of timber—its location, kinds, amount, etc.; second, how to conserve the present forests so as to make them a source of future and continuing supply (how many lumbermen now think of selecting and preserving seed trees, as the stockman will preserve and care for his brood stock?); third, a reforestation of areas better adapted to the raising of trees than of anything else and that never should have been deforested. These are the lines along which the Survey plans to gather and publish information.

What the railroads have been in the building up of the country at large, good roads may be in the building up of smaller divisions of the country. There are three factors of cost of farm products or lumber—cost of production, of transportation, of distribution. Every dollar saved in any of these three points is a dollar earned. If it costs the farmer twenty cents a bushel to haul his wheat to market over a poor road and ten cents over a good road, and he raises one thousand bushels, the poor road has cost him just one hundred dollars for the moving of that one crop alone.

The Geological Survey hopes to be able to aid in the building of good roads in at least three ways: First, through the detailed topographic maps, which will aid in showing the amount of rise or fall a road will have to have in going from any one point to another, and then showing where it can be placed so as to keep within the maximum grade decided on, for as the strength of a chain is determined by its weakest link, so the hauling efficiency of a road is measured by its steepest grade; second, it may help by locating, testing, and mapping materials suitable for the building of roads; third, in connection with the last in coöperation with the Good Roads Division of the Federal Agricultural Department, it may point out and illustrate methods of road building, use of materials, etc., in addition to what it may do by publication of road maps and general information about roads.

WORK OF THE SURVEY.

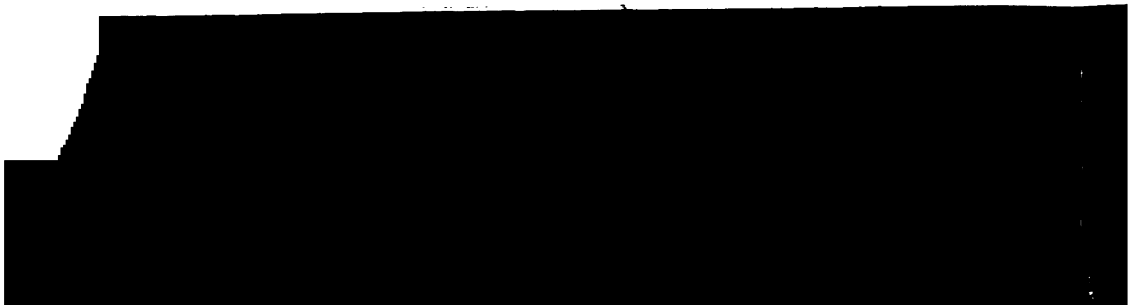
The work of the Survey will fall under the following heads:

1. Field work.
2. Office work.
3. Laboratory work.
4. Exhibit and educational work.
5. Publication.

Field Work.—The field work will vary in character and methods in accordance with the objects sought. While the great bulk of the work will consist of detailed studies and mapping, in most cases this will have to be preceded by preliminary studies. These preliminary studies will be made at the points at which any given mineral resource is or has been developed. Such work will consist of personal visits to the various active plants by some member of the Survey, the examination and measurement of the deposits to determine their origin, age, relationships, mode of occurrence, size, quantity, quality, character, methods of extraction, the process of smelting or recovery, etc. These reports will usually be accompanied by sections and maps. The facts obtained will be of value in showing the present condition of the industry involved, the kind of material used, how it occurs, etc. These facts will also be used and be necessary for determining the condition of occurrence on which the future detailed studies and mapping will be based.

In some cases this work will consist of excursions to examine some locality at which it has been reported there occurs some ore or mineral of wide interest or value; or the work may be a reconnaissance study of all of the known occurrences of some resource, as of coal, oil, or phosphate.

The detailed work will be of two kinds—areal work and the tracing and study of some one resource. In many cases the areal work will be done in connection with the study of the principal resource of that area. In the areal work a set of traverse lines is run all over the area, some of them following the streams and gullies, some the roads, some the hillsides, following along the outcropping of a bed of rock or mineral, others filling in the spaces between, as it may be necessary in order to complete the mapping or to examine some prospect or mine. As these traverses are run a record is made, by means of a double system of notes on field maps and in notebooks, of every geologic fact, including a graphic description of every outcrop of rock, its thickness, color, grain, bedding, dip, etc.; if possible, its stratigraphic position is determined



or noted, if known; fossils are collected wherever necessary; samples and specimens are collected for analysis, study, or exhibit. The notes are made in such a way as to show accurately the horizontal and vertical relations of all of the facts collected. In this way, no matter how fragmentary the facts may be, they are fitted at once into their proper place, and, as the work progresses, data lacking at one point may be supplied from some other point. Gradually it becomes possible to fill in the lacking information to a greater or less degree, just as it becomes possible to fill in a picture of a partially set up puzzle, even though most of the pieces are still lacking, for, wherever these traverses may go, all are so tied together that the relations of any fact obtained on one becomes obvious to all of the facts on any other line.

If beds or deposits of known or suspected economic importance are encountered, they are examined in more minute detail following certain more or less well-defined lines of procedure; if desirable or necessary, efforts are made to secure better exposure of some economic deposits. Wherever possible, the information obtained directly by the geologist in the field is supplemented by reports of drilling and prospecting made by mining and prospecting companies, by observations made by those residing in the district, or by any other data obtainable.

In the detailed study of any selected economic resource, all of the conditions of its occurrences, its character, quantity, etc., are determined by the preliminary study. The main work will include the detailed tracing of the occurrence of these conditions wherever the general conditions make it possible for them to exist.

From what has just been said and from what was said under "Scope of Work," it is evident that all of the detailed mapping will require detailed topographic maps. It is not enough to say that such and such a coal bed outcrops within a mile to the east of such and such a town, or that it underlies between one hundred thousand and two hundred thousand acres. Its outcrop should be shown within at least a few hundred feet horizontally and a very few (twenty) feet vertically (generally much nearer); the area it underlies should be known within at least a few hundred acres. It will not always be possible to secure such accurate results, but results as close or closer will always be aimed at.

To do detailed work in the oil and gas, phosphates, soils, cement work, clays, and most other materials, will require the same detailed topographic base maps as in working the coal or iron, if the results obtained in the field are to be adequately represented.

DSE, SCOPE, AND

all of the various methods
is results are to be secured.
ral bureaus, which will co-
mapping, oil and gas work,
ed in detail in publications
many cases will be given in
to be published by this Sur-
from these described will
materials or underground wa-
such subjects.

consist, first, of the corre-
the planning and carrying
the identification of speci-
supplying information about
urvey is concerned, especially
materials, etc.; fourth, the
about mines, drillings, etc.,
third clause and partly in
publication; fifth, the working
and the preparation of the
relating to the natural
of preliminary circulars
of the literature.

may be made of some of the
first lines taken up is that
prosecution of previous Na-
other surveys and studies, a
has already been gathered.
ications of many kinds, some
can be obtained only with
information on any one subject
through a dozen or a score of

the detailed studies to be made
ready for some years, pre-
be prepared as rapidly as
information available at the
specially be gathered for the use
brief, summarized form, will
reports of the detailed work

old material for publication

character of the work. Where the surface, the report may be made in field notes properly arranged, usually with a map, and the comparison of the time required for the field notes themselves are used as a basis for computations, reaching conclusions in terms of the map, etc. In cases where the surface is almost or entirely underground, and other such resources, the data are of a different character, and often so incomplete that this is a long, slow job, involving the projecting of surface dips from the underground, with all of the necessary corrections for the dip due to the change in the constant application of the known conditions occurring in the field. There is no doubt exists as to the value of the surface, it may be necessary to make a series of sections and carry the full set of data to determine the bed's most probable position, etc., of the subject of study. The seeming long delay in the surface between the field work and the underground, however these underground de-

to-day forms no small part of a given piece of field work records of wells or prospects. The field work is to be done, the records. Experience has shown them when they are available. These unless properly classified are of little use or value when wanted. The same thing is true of the mines and quarries, of the records and of information received from the various callers. The Survey will be of little use in planning and caring for this material.

Survey always stands ready

to supplement the reports with any personal explanation that may be necessary. It is intended that in any case the report will give all of the information possessed by the Survey (except confidential data); but the writer realizes that, in applying the conclusions of a report to any particular locality, it is not always easy to see or understand just what the result of the application will be locally.


The identification of specimens brought or sent to the Survey has always been recognized as one of its legitimate functions. While it is true that it is only rarely that specimens so received by the Survey have any wide interest or value, and that a large share of the specimens prove to contain only mica or pyrite (fool's gold) or other substance that is of no value in the form in which it occurs in the specimen, yet it is as much the function of the Survey to prevent the useless expenditure of money on noncommercial projects as to encourage its expenditure on other projects.

The correspondence and other work necessary to the planning and carrying on of the work of the Survey may be judged by the success or otherwise of the work itself.

Laboratory Work.—In accordance with the general plan of not duplicating plants in existence or work already being done, the Survey does not plan to establish elaborate chemical or physical laboratories at this time. On the other hand, it plans to make use, as far as it may, of the laboratories already in existence, such as those of the State Chemist, the State Agricultural Experimental Station, the new Federal Bureau of Mines, and the several laboratories of the Federal Agricultural Department. In this way it will be possible not only to avoid the large expense of equipping full laboratories, but in many cases it may be possible to secure coöperation in the laboratory work so as to obtain a division of the expense.

In most cases it will be possible to secure such coöperative laboratory work only where the work being done is of interest to the coöperating bureau or department. There will doubtless arise from time to time many minor chemical questions which will make it desirable that the Survey be equipped to make simple qualitative tests in the prosecution of its work, and it will be so equipped. In another part of this bulletin a statement is made of the Survey's policy in regard to doing analytical work for private parties.

In addition to the chemical analysis of the various materials constituting the resources of the State, there are to-day many experiments being carried on looking to the better utilization or preparation of the mineral resources of the State. The Technologic Branch of the Federal Geological Survey, which now forms part of the new



several years been carrying on utilization of coal and other member of experimental laboratory of the University of Illinois, that

While this Survey does not at this time, it will plan to do work being carried on elsewhere through the medium of a direct bearing on the utilization. In addition to that work, it application of any of those suggestions applied in this State, or of carried on within the State

is spelled in good management mainly a matter for the individual. The second point comes as a comment. In the mining, metal of nature's resources, there is

many districts but little more obtained by mining; in others. It has often happened is of preparing the coal for per cent may be made in the or in the price obtainable for of an additional ton. The more than five per cent to ten coal. Power equipments are twenty per cent to thirty per cent the same amount of coal by first and the use of that in a gas look forward to a day when all Eastern and Middle Tennessee will be generated at the mines electrically to where it is to be fuel is another item of large

This work will consist, first, of the various ores, minerals, with specimens illustrating refining, smelting, screening,

USE, SCOPE, AND

second, of the preparation of
displayed; third, of the prep-
e's resources at the exposi-
fourth, of the preparation of
material collected by the Sur-
of the State as give courses
th, the preparation of "pop-
of the origin and mode of
the mineral resources of the
anges of East Tennessee, of
of Middle Tennessee, of the
and other objects of special
of soils, of the simple prin-
sixth, of the giving of talks
other members of the Sur-
; seventh, of the preparation
see and its resources for out-
calling attention to the op-
ess enterprises or profitable
its advantages as a place of
other advantages.

urvey's work are to be pub-
ully as they are prepared, and
of the first bulletins, which
ing together of our present
of the State, the bulletin may
a small edition of the indi-
ready to supply the demand
papers will be treated as
information."

ins must come from the ap-
will be kept as small as pos-
ute them with care in order
those having a real interest
on no widespread distribution
ear. They will be sent free
he press, State officials, for-
ining, agriculture, and for-
tive coöperation with the de-
ervice in the work in hand.
quiry or otherwise have ex-
subject treated, and they and

copies of the bulletins upon

since that long after the edi-
 tion continue to come requests
 having large interests in the
 making local investments, and
 may result in a distinct loss
 of five hundred copies of each
 cost of publication. This
 need of late comers, who, if
 of the report, can hardly ob-
 tain the information they de-
 siring the Survey, all funds
 to the State Treasury.

be small, and as it is often
 care for small bulletins, the
 each bulletin unbound until
 these parts together into a
 distribution of bulletins to
 end of the year.

all into five classes:

1. Such information as would
 general interest in the sub-
 the State making general in-
 road subjects involving the
 primary papers on such large
 detailed descriptions will fill
 until the study of any

2. The results of detailed stud-
 of a county. The bul-
 cluded under this head. As
 relating to some subject rather
 detailed studies of the counties
 the study of the principal re-
 sults on the various counties
 improvements.

3. Geologic descriptions of de-
 scription or mining, or other mat-

PROPOSE, SCOPE, AND

combustion of coal, the elec-
prevention of hillside wash,

18.

the minerals or rocks of the
physiography, etc.

administrative report of the di-
rector, reports of partial re-
sults, etc.

CON.

Survey, it has been the idea of
the people of Tennessee was
the Survey as to secure certain
and at the smallest possible
States has shown that by co-
which are thoroughly equipped
with specialists who have been
take the field at once, that any
less cost to the State than for
itself.

have been entered into with
Geological Survey and with several
department, in addition to co-
operation of the other departments of
agreements, as a rule, the
of a government expert, the
shared equally. In many cases
agencies and the State Govern-
as a rule, will not amount to
costs, as in the coöperation with
two types of reports are pre-
pared for the State, and a scientific
report for the national government. As a rule,
the amount and grade of work to be
provided such proposed work will
be determined by the several bureaus concerned. So
far as coöperative agreements with
other departments that the funds of some of
the departments are to coöperative work, so that

States not coöperating have very little work done in them by these bureaus.

Some of the advantages to the State with these coöperative agreements may be cited: In the first place, the amounts of such work done in this State and made available to its citizens is nearly twice as large as the State Geological Survey could do alone; in the second place, the State reaps the advantage of having the work done by trained specialists without having to build up or train a corps of high-salaried men for possibly small amounts of work in each of their lines; in the third place, the national bureaus usually have facilities for engraving and printing the maps showing the results of the surveys, and transfers of such maps may be obtained by the State for its own use at a small fraction of what the engraving costs; in the fourth place, many of the geologic and other features occurring in this State are parts of large provinces extending over many adjacent States, and the members of the Federal bureaus bring to the work in this State a knowledge of the conditions in other States in which the same formation is found.

There are, of course, many phases of work in which the State Survey has a vital interest, in which the Federal bureaus do not have an interest, and in which they will not, therefore, coöperate. In many respects their interest is more of a general nature than a purely economic, whereas the State Survey is primarily economic and only secondarily deals with matters of general interest. The State Survey is, in a sense, an advertising agency for the State's resources, and in that line naturally the Federal surveys can take no part. There are many types of reports that must be gotten out by the State Survey in pursuance of the particular objects it has in view, in which it cannot coöperate with the Federal surveys.

In general, in planning coöperative work, the attempt is made to secure such coöperation for the most detailed and expensive lines of work, while reconnaissance work and other studies dealing with purely local matters will be taken up by the State Survey.

For the first season coöperative agreements have been made with the Geologic and Topographic Branches of the United States Geological Survey, and with the Bureau of Soils, the Public Roads Division, and Drainage Investigations of the Federal Department of Agriculture, and tentative plans have been made with several other bureaus and departments for coöperative work in the future. As a rule, the Federal bureaus pay salaries and the State pays expenses, so that its money does not go out of the State. Where the work is largely of purely local interest, as in the drainage surveys, a large part of the expense is borne by the local interests.

RELATIONS TO THE PUBLIC.

In common with all of the national and State Surveys, the Geological Survey of Tennessee has certain rules and regulations which prohibit the director or any member of the Survey from having any personal or private interest in any of the lands or mineral wealth of a region under survey or from executing any surveys or examinations for private parties or corporations in this State. This is absolutely necessary if the reports of the Survey are to be kept free from any suspicion of bias or willful misrepresentation.

Except where the results will be of large public interest, the Survey will not undertake the examination of property for private parties, as that work properly belongs to the mining geologist or mining engineer.


Rocks or minerals properly packed and sent, postpaid, to the director will be examined without cost, providing an assay or chemical analysis is not necessary. Exception to the latter rule may be made if the director believes the specimen to contain valuable mineral, the determination of which will be of value to the work of the Survey and an aid in the study of the resources of the State. When requested, names of reliable parties will be given, who may be employed to furnish assays or chemical analyses. The Survey reserves the right to publish, at any time, any assay or analysis made at its expense.

Two of the regulations are of such character that they had best be quoted in full:

"Members of the survey are expressly forbidden to give individuals or corporations, in advance of publication, the results arrived at in the course of geological examination in a district or area. They are at liberty, however, to communicate orally to the owner or manager of a mineral property, during the progress of its investigation, such information with regard to the geology of that property as may be of value to him in its development; but written statements must be avoided, lest they be used for promoting or unduly enhancing values."

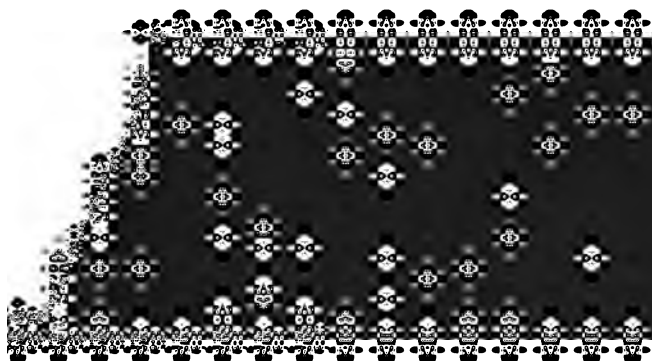
"Information of a confidential character, such as mine maps, drill records, statistics of production, etc., supplied by private parties or corporations, must be carefully guarded and used in the preparation of reports for publication strictly in accordance with the conditions stipulated by the persons furnishing it."

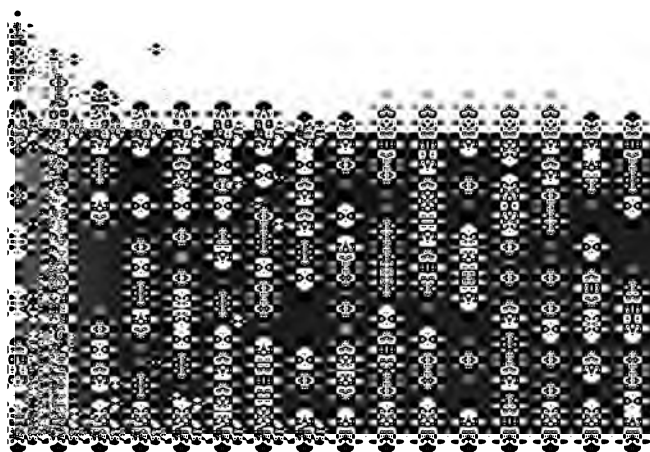
In general, in planning the work for each season, the plans are largely influenced by the volume and character of inquiries for information that have been received, modified by the existence of adequate base maps or other limiting factors. As already explained, it will not pay to attempt to do detailed geological work in a region

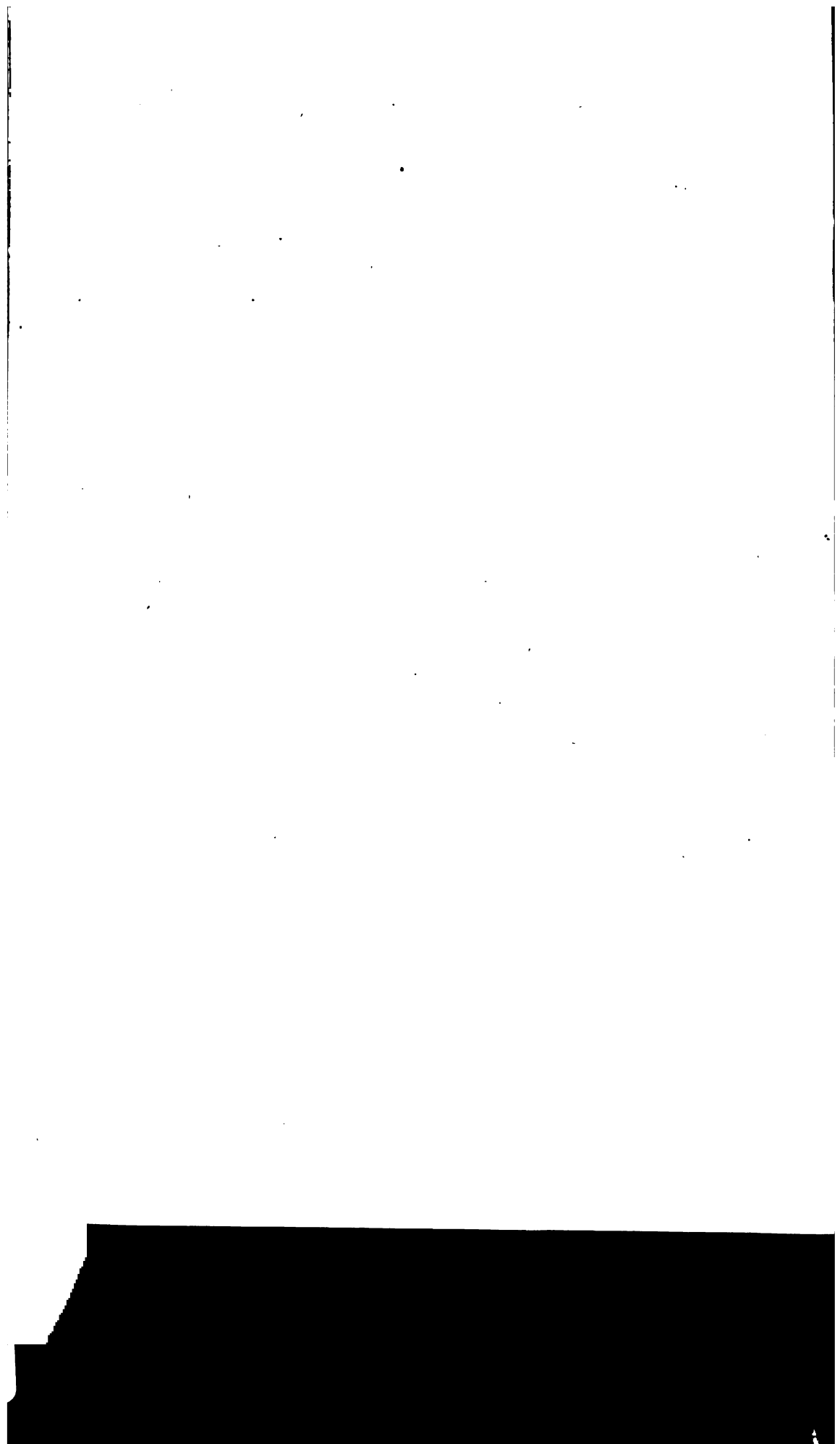


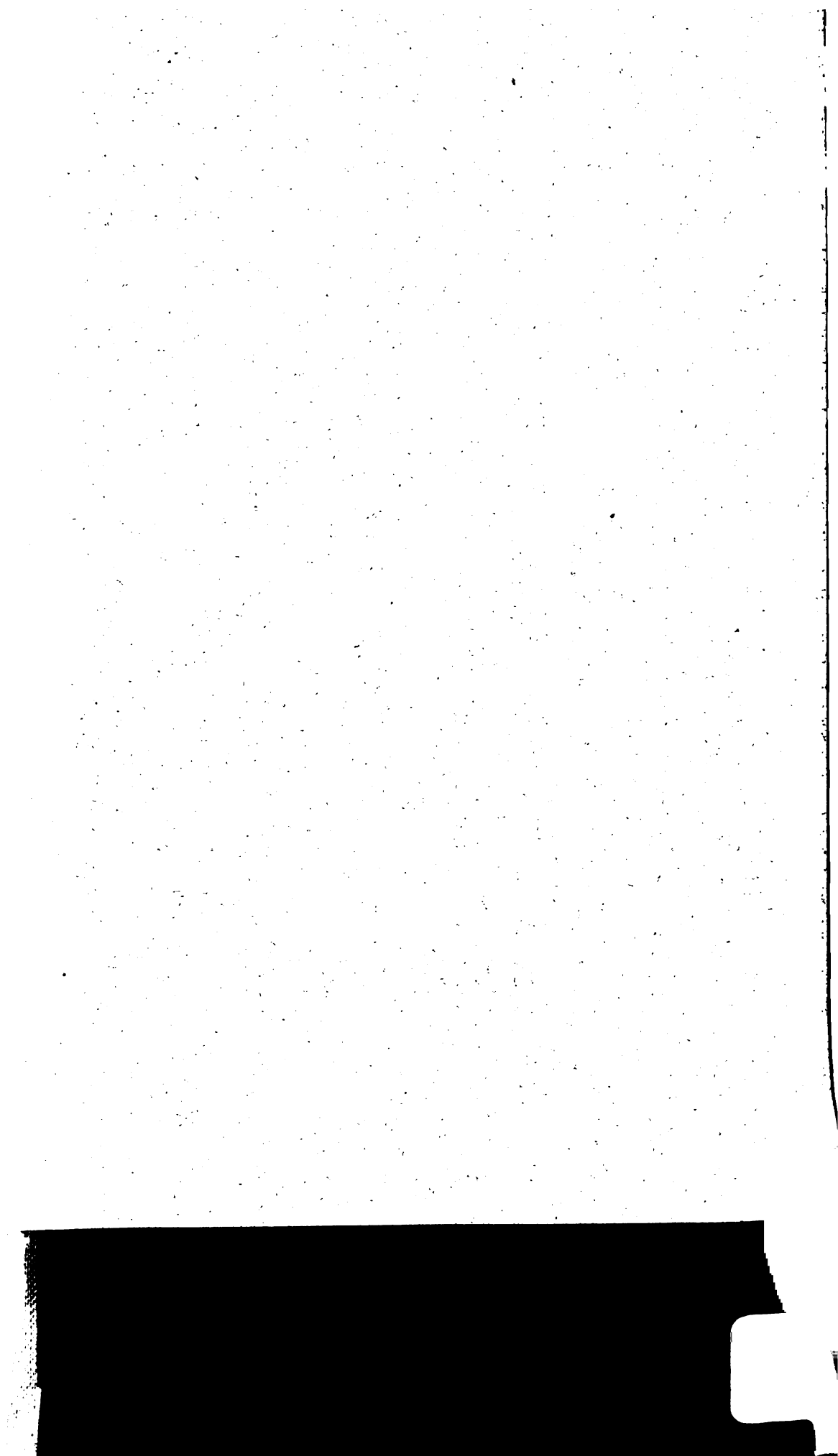
and before work of that character an adequate base map must be made possible to make reconnaissance as yet been topographically small number of up-to-date than any other, will determine. In the beginning, however, such work will be desirable in certain districts.

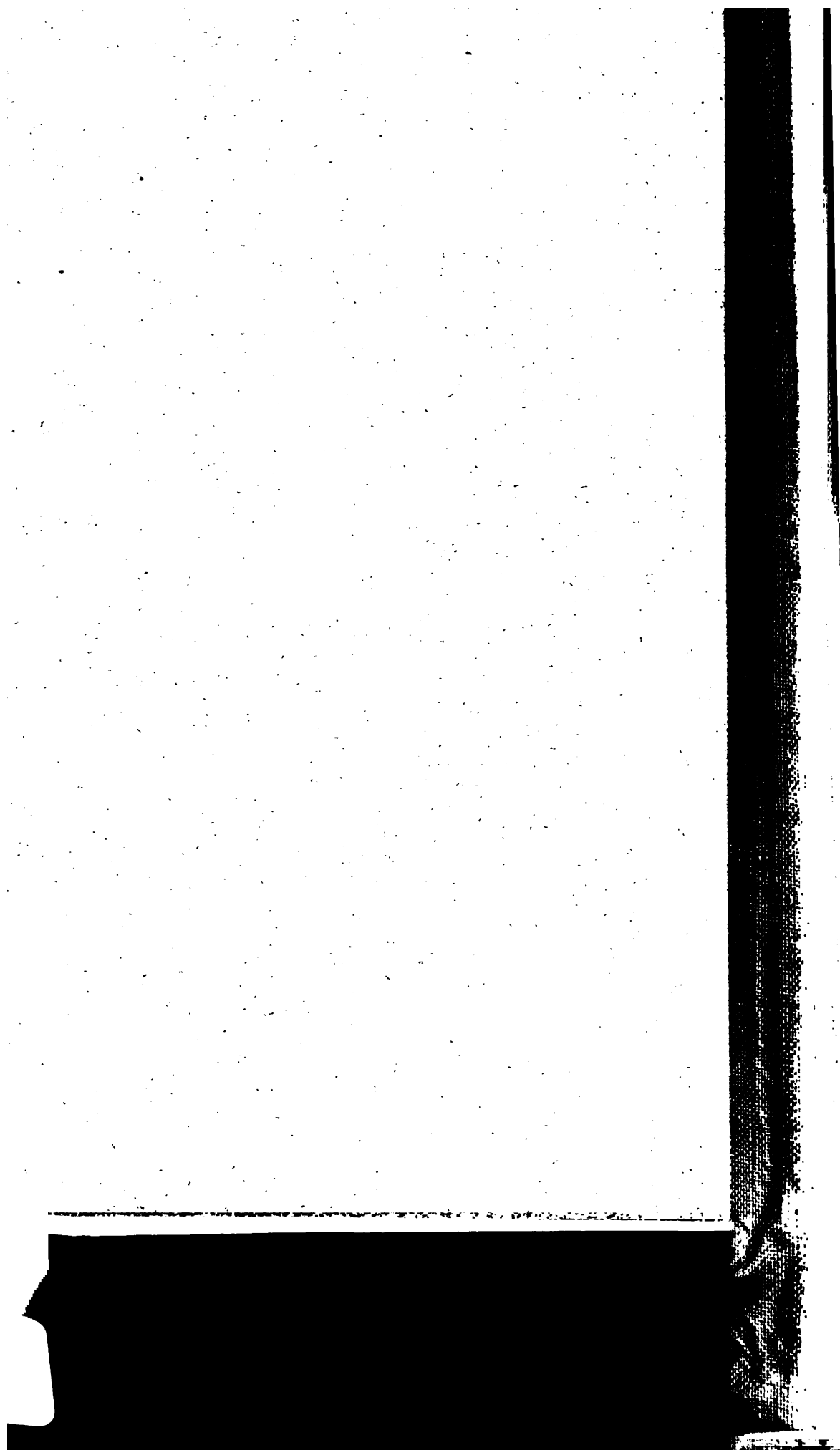
It is a district believe that disvalue, and under these circumstances, glad to have his attention to the limitations imposed by the compliance with requests for such number of people are interested in the State appropriation made early enough in the year for the doing of such work at the season's work.











.A8

7, George H.

ishment, purpose, scope and
ods of the State Geological
ey

BORROWER'S NAME

DATE DUE

PRINTED IN